e-ISSN: 3108-2866; p-ISSN: 3139-4108
Available online on https://jmmdt.jcpublications.in
Journal of Medicine, Pharmacology and Medical Devises Technology. July 2026; 2(07): 6 – 10.
doi: https://doi.org/10.67170/jmmdt.2026.v2i7.002 Original Research Article

When the Cannula Becomes a Reservoir: Microbial Colonisation and Local Complications of Peripheral Intravenous Access in Hospitalised Children

Amtul Saleem Asfa[1], G J Archana[2], NK Gupta[3]
[1]Senior Resident, department of Pediatrics, Modern Government Maternity Hospital, Petlaburz, Hyderabad.
[2]Associate Professor, department of Microbiology, Government Medical College, Quthbullapur, Medchal, Malkajgiri.
[3]Professor, department of General Medicine, Pacific Institute of Medical Sciences, Udaipur, Rajasthan.

Date of submission: 15-05-2026 Date of Review: 23-05-2026 Date of acceptance: 26-07-2026
Corresponding Author: Dr NK Gupta
Conflict of interest: Nil

Abstract

Background: Peripheral intravenous cannulas are widely used in paediatric care but may become colonised by microorganisms and contribute to local complications or infection. **Aim:** To determine the frequency, microbial profile and antimicrobial susceptibility pattern of peripheral intravenous cannula colonisation and its association with device-related complications in hospitalised children.

Methods: This prospective observational study was conducted in the Departments of Pediatrics and Microbiology, Pacific Institute of Medical Sciences, Udaipur, Rajasthan, from October 2025 to April 2026. A total of 150 hospitalised children with peripheral intravenous cannulas were enrolled. Cannula-related clinical and device characteristics were recorded. Removed cannula tips were cultured, organisms were identified and antimicrobial susceptibility testing was performed.

Results: Microbial colonisation was detected in 38 cannulas, giving a frequency of 25.3%. Colonised cannulas had a significantly longer mean dwell time than non-colonised cannulas. Dwell time exceeding 72 hours, multiple insertion attempts, emergency insertion and undernutrition were significantly associated with positive cultures. *Staphylococcus aureus* was the commonest isolate, followed by coagulase-negative staphylococci and *Klebsiella pneumoniae*. Phlebitis occurred in 52.6% of culture-positive cannulas compared with 16.1% of culture-negative cannulas. Erythema, tenderness, swelling, blockage and local discharge were also significantly associated with colonisation.

Conclusion: Peripheral intravenous cannula colonisation was common and was strongly associated with prolonged dwell time and local complications. Regular site assessment, strict aseptic handling and timely device removal may reduce colonisation and related morbidity.

Keywords: Peripheral intravenous cannula; Microbial colonisation; Paediatric patients; Phlebitis; Device-associated infection

This is an open-access journal, and articles are distributed under the terms of the Creative Commons Attribution License CC-BY 4.0. (https://creativecommons.org/licenses/by/4.0/) which permits unrestricted use, distribution, and reproduction in any medium, provided the original authors and source are credited. The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the journal, its editorial board, or the publisher. The journal does not assume any responsibility for the accuracy or completeness of the information provided.

Introduction:

Peripheral intravenous cannulas are among the most frequently used medical devices in paediatric practice for administering fluids, medications, antibiotics and blood products. However, repeated handling, prolonged dwell time, inadequate aseptic precautions and contamination of cannula hubs may promote microbial colonisation, resulting in phlebitis, local infection or bloodstream infection (BSI). An Indian paediatric quality-improvement study demonstrated that an evidence-based care bundle markedly reduced peripheral cannula-related phlebitis, highlighting the importance of insertion-site surveillance and device-care practices [1]. Recent multicentre Indian surveillance also documented considerable central line-associated BSI rates in paediatric and neonatal intensive care units, with antimicrobial-resistant organisms posing an important treatment challenge [2]. Similarly, implementation of a structured central-line care bundle in an Indian neonatal unit substantially reduced infection rates [3]. Nevertheless, microbiological evidence concerning colonisation of short peripheral cannulas in hospitalised Indian children remains limited. Therefore, the present study aimed to determine the frequency, microbial profile and antimicrobial susceptibility pattern of peripheral intravenous cannula colonisation and its association with device-related local complications in hospitalised children.

Methods:

A hospital-based prospective observational study was conducted in the Departments of Pediatrics and Microbiology, Pacific Institute of Medical Sciences, Udaipur, Rajasthan, from October 2025 to April 2026. Hospitalised children aged one month to 18 years who required peripheral intravenous cannulation for administration of fluids, medications, antibiotics or blood products were screened consecutively for eligibility. Children whose peripheral intravenous cannula remained in place for at least 24 hours were included after written

e-ISSN: 3108-2866; p-ISSN: 3139-4108
Available online on https://jmmdt.jcpublications.in
Journal of Medicine, Pharmacology and Medical Devises Technology. July 2026; 2(07): 6 – 10.

informed consent was obtained from a parent or legally authorised guardian. Children with a cannula inserted at another hospital, cannulas removed accidentally before specimen collection, grossly contaminated specimens, pre-existing infection at the insertion site, severe immunodeficiency or refusal to participate were excluded. Ethical approval was obtained from the Institutional Ethics Committee before initiation of the study. Demographic and clinical information, including age, sex, primary diagnosis, nutritional status, comorbidities, indication for cannulation, ongoing antimicrobial therapy and duration of hospitalisation, was recorded using a structured case-record form.

Peripheral intravenous cannulation was performed by trained doctors or nursing personnel under aseptic precautions according to the institutional protocol. Details related to the device were documented, including cannula gauge, anatomical insertion site, number of insertion attempts, emergency or elective insertion, type of dressing, frequency of manipulation, medications administered through the cannula and total dwell time. The cannula site was examined daily for pain, tenderness, erythema, swelling, induration, local warmth, discharge, leakage, blockage and palpable venous cord. Phlebitis was assessed using a standard visual infusion phlebitis grading scale. The reason for cannula removal was recorded as completion of treatment, blockage, infiltration, accidental dislodgement, suspected phlebitis or suspected infection. At removal, the surrounding skin was disinfected, and the distal 2–3 cm segment of the cannula was cut using sterile scissors and transferred immediately into a sterile, labelled container. Specimens were transported without delay to the Microbiology laboratory for processing.

Cannula-tip specimens were inoculated on appropriate culture media using a standard semiquantitative culture technique and incubated under recommended aerobic conditions. Microbial growth was identified by colony morphology, Gram staining and routine biochemical or automated identification methods available in the laboratory. Significant colonisation was defined according to the laboratory's accepted colony-count criteria. Antimicrobial susceptibility testing was performed using the Kirby–Bauer disc diffusion method or an automated system and interpreted according to current Clinical and Laboratory Standards Institute guidelines. The primary outcome was the frequency of peripheral intravenous cannula colonisation. Secondary outcomes included the spectrum of isolated organisms, antimicrobial susceptibility pattern and association of colonisation with dwell time, insertion site, insertion attempts, cannula gauge and local complications. Data were analysed using appropriate statistical software. Continuous variables were expressed as mean with standard deviation or median with interquartile range, while categorical variables were presented as frequency and percentage. Chi-square test, Fisher's exact test, independent t-test or Mann–Whitney U test was applied as appropriate. A p-value below 0.05 was considered statistically significant.

Results:

A total of 150 hospitalised children with peripheral intravenous cannulas were evaluated. Significant microbial colonisation was identified in 38 cannula tips, giving a colonisation frequency of 25.3%. The mean age and sex distribution were comparable between culture-positive and culture-negative children. However, undernutrition was significantly more frequent among children with positive cultures. Culture-positive cannulas had a longer mean dwell time than culture-negative cannulas (76.6 ± 25.4 versus 51.8 ± 20.7 hours; $p<0.001$). Dwell time exceeding 72 hours, multiple insertion attempts and emergency cannula insertion were also significantly associated with colonisation (Table 1). *Staphylococcus aureus* was the commonest isolate, followed by coagulase-negative staphylococci and *Klebsiella pneumoniae*. Four *S. aureus* isolates were methicillin resistant, while four of the six *Klebsiella* isolates were resistant to ceftriaxone (Table 2). Local complications were substantially more common in culture-positive cannulas. Phlebitis occurred in 52.6% of culture-positive cases compared with 16.1% of culture-negative cases, corresponding to an odds ratio of 5.80. Erythema, tenderness, swelling, blockage and local discharge were also significantly associated with microbial colonisation. Overall, 71.1% of culture-positive cannulas developed at least one local complication compared with 33.0% of culture-negative cannulas ($p<0.001$) (Table 3).

Discussion:

The present prospective study demonstrated microbial colonisation in 38 of 150 peripheral intravenous cannulas, corresponding to a frequency of 25.3%. Although colonisation of a cannula tip did not necessarily indicate BSI, it represented microbial adherence to an invasive device and a potential preliminary stage in the development of local or systemic infection. Peripheral intravenous cannulas are frequently regarded as low-risk devices compared with central venous catheters; nevertheless, their widespread use, repeated manipulation and frequent insertion under urgent clinical circumstances may produce a substantial cumulative burden of device-related complications. Diwakar et al. identified peripheral venous catheter-related phlebitis as an important problem in an Indian paediatric critical care unit and demonstrated that structured surveillance and improved cannula-care practices reduced its incidence [1]. The colonisation frequency observed in the present study

indicated that apparently uncomplicated peripheral cannulas might harbour clinically relevant organisms even when BSI was not established. Recent Indian surveillance data have also confirmed that intravascular device-associated infections remain important in paediatric and neonatal units. Parveen et al., in a multicentre Indian surveillance network, reported central line-associated BSI rates of 6.71 per 1,000 central line-days in paediatric intensive care units and 13.86 per 1,000 central line-days in neonatal intensive care units [2]. Although those findings concerned central lines, they reinforced the principle that every intravascular device should be inserted, accessed and maintained using rigorous infection-prevention practices.

Prolonged cannula dwell time emerged as one of the strongest device-related factors associated with microbial colonisation. Culture-positive cannulas had a significantly longer mean dwell time than culture-negative cannulas, and almost two-thirds of colonised devices had remained in place for more than 72 hours. Increasing dwell time may permit progressive contamination of the cannula hub, migration of skin organisms along the catheter surface and development of an adherent microbial biofilm. However, prolonged dwell time should not be interpreted in isolation because the condition of the insertion site, frequency of access, integrity of the dressing and continued clinical requirement are equally important. Multiple insertion attempts and emergency insertion were also significantly associated with positive cultures. Repeated attempts can cause tissue injury, increase contact between the device and surrounding skin and compromise aseptic technique, whereas emergency procedures may occur under time pressure with less optimal preparation. Similar concerns have been reported for long-term paediatric vascular devices. Sahu et al. found catheter-associated BSI in 28.6% of tunnelled catheters inserted in children and identified younger age, neutropenia and total parenteral nutrition as significant risk factors [4]. Improvement of device handling may reduce infection even when the device cannot be removed early. Tom et al. showed that introduction of a structured care bundle improved the care and maintenance of port-a-cath devices in children receiving oncology treatment [5]. These observations support daily assessment of peripheral cannula necessity, prompt removal of unnecessary devices, minimisation of insertion attempts, maintenance of clean and intact dressings and strict hub disinfection before every access.

The predominance of *Staphylococcus aureus* and coagulase-negative staphylococci in the present study suggested that the patient's skin, the hands of healthcare workers and manipulation of the cannula hub were probable sources of contamination. These organisms possess the ability to adhere to synthetic surfaces and produce biofilms, allowing persistence despite routine cleaning and exposure to antimicrobial agents. Coagulase-negative staphylococci should not automatically be dismissed as contaminants, particularly when recovered from intravascular devices in vulnerable children. Ansari et al. reported that coagulase-negative staphylococci constituted an important proportion of neonatal bloodstream isolates in an Indian tertiary-care centre, with 70% of the isolates demonstrating methicillin resistance [6]. The recovery of methicillin-resistant *S. aureus* from four cannula tips in the present study was therefore clinically relevant. Gram-negative organisms, including *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Escherichia coli* and *Acinetobacter* species, were also isolated. The detection of these hospital-associated organisms may indicate contamination through hands, fluids, connectors or the surrounding healthcare environment. Kartikeswar et al. documented a high burden of BSI among neonates with central venous catheters in three tertiary neonatal units in Pune, with substantial antimicrobial resistance [7]. It was reported similarly in central line-associated BSIs in Indian intensive care units caused by resistant Gram-negative organisms, including considerable carbapenem resistance [8]. Thus, the microbial profile identified in the present study supported the need for coordinated surveillance by paediatricians, microbiologists and infection-control personnel.

The antimicrobial susceptibility findings were also important. Four of six *Klebsiella pneumoniae* isolates were resistant to ceftriaxone, while resistance to fluoroquinolones and other commonly prescribed agents was observed among several Gram-negative isolates. One *Acinetobacter* isolate demonstrated carbapenem resistance. These findings should be interpreted cautiously because cannula-tip colonisation alone does not justify systemic antibiotic treatment in the absence of clinical infection. Nevertheless, colonised devices may serve as reservoirs for resistant organisms and may contribute to transmission within paediatric wards. Investigations from India have repeatedly documented the growing antimicrobial-resistance burden among neonatal and paediatric bloodstream isolates. Pathak et al. described an outbreak of colistin-resistant and carbapenemase-producing *Klebsiella pneumoniae* causing neonatal BSIs, highlighting the capacity of resistant clones to spread in high-risk units [9]. Investigators also demonstrated that nosocomial transmission, rather than maternal colonisation alone, was an important source of drug-resistant BSIs in neonates [10]. A recent multicentre Indian study of non-central line-associated primary BSIs further demonstrated that healthcare-associated BSIs may occur even without a central line and are associated with a diverse microbiological profile [11]. Accordingly, antimicrobial susceptibility testing of clinically significant isolates, adherence to antibiotic-

stewardship policies and avoidance of empirical broad-spectrum therapy for uncomplicated cannula-site assessment inflammation are essential.

Local complications were markedly more common in children with colonised cannulas. Phlebitis was present in 52.6% of culture-positive cannulas compared with 16.1% of culture-negative cannulas, and colonisation increased the odds of phlebitis by nearly six times. Erythema, pain, tenderness, swelling, blockage and discharge were also significantly associated with positive cultures. Local discharge showed the strongest association, although its confidence interval was wide because of the small number of cases. These findings indicated that careful bedside examination could help identify devices at increased risk of microbial colonisation. However, local inflammation may also result from chemical irritation, mechanical trauma or infiltration; therefore, clinical findings should be correlated with microbiological and systemic evidence before diagnosing catheter-related infection. Indian quality-improvement studies have shown that device-associated infection rates can be reduced through simple, reproducible interventions. Kaur et al. achieved a progressive reduction in paediatric intensive-care-unit CLABSI rates through staff participation, infrastructure improvement, training, audit and feedback [12]. Biswas et al. similarly reported a reduction in neonatal CLABSI after implementation of insertion and maintenance bundles [3].

Conclusion: The present findings therefore support daily cannula-site assessment, documentation using a standard phlebitis scale, hand hygiene, aseptic non-touch technique, adequate skin preparation, hub disinfection, secure fixation and immediate removal when pain, erythema, discharge, blockage or loss of clinical indication occurs. The prospective design and microbiological confirmation strengthened this study; however, its single-centre setting, moderate sample size, absence of paired blood cultures in every child and inability to distinguish transient contamination from established biofilm were limitations. Larger multicentre studies using quantitative cultures, molecular typing and paired blood cultures would help determine whether colonised peripheral cannulas directly contribute to BSI in hospitalised Indian children.

References

1. Diwakar K, Kumar S, Srivastava P, Uddin MW, Mishra S. Reduction in the incidence of infusion-related phlebitis in a pediatric critical care unit of Eastern India: A quality improvement initiative. Med J Armed Forces India. 2024; 80(1): 46 – 51. doi: 10.1016/j.mjafi.2021.07.010.
2. Parveen R, Thakur AK, Srivastav S, Puraswani M, et al. Profile of central line-associated bloodstream infections in adult, paediatric, and neonatal intensive care units of hospitals participating in a health-care-associated infection surveillance network in India: a 7-year multicentric study. Lancet Glob Health. 2025; 13(9): e1564 – e1573. doi: 10.1016/S2214-109X(25)00221-9.
3. Biswas J, Joshi A, Londhe AC, Deshmukh L, Tanpure S, Iravane J. From lines to lifelines: a quality improvement study to reduce CLABSI at a level III NICU in LMIC. BMJ Open Qual. 2026; 15(1): e003891. doi: 10.1136/bmjoq-2025-003891.
4. Sahu A, Zameer MM, Vinay C, Rao S, D'Cruz A. Catheter-associated Bloodstream Infection in Children with Tunneled Central Venous Catheters: A Single-center Experience. J Indian Assoc Pediatr Surg. 2024; 29(4): 329 – 33. doi: 10.4103/jiaps.jiaps_248_23.
5. Tom A, Acharya AR, Kamath A, Venugopal A, Lashakri HP. Improvement in Care and Maintenance of Port-A-Cath Following the Introduction of Care" Bundle. J Indian Assoc Pediatr Surg. 2022; 27(5): 600 – 4. doi: 10.4103/jiaps.jiaps_254_21.
6. Ansari F, Banerjee T, Kumar A, Anupurba S. Coagulase-Negative Staphylococci in Neonatal Blood: How Concerning? J Lab Physicians. 2023; 15(1): 126 – 30. doi: 10.1055/s-0042-1757411.
7. Kartikeswar GAP, Parikh TB, Randive B, Kinikar A, et al. Bloodstream infections in neonates with central venous catheters in three tertiary neonatal intensive care units in Pune, India. J Neonatal Perinatal Med. 2023; 16(3): 507 – 16. doi: 10.3233/NPM-221110.
8. Singhal T, Shah S, Thakkar P, Naik R. The incidence, aetiology and antimicrobial susceptibility of central line-associated bloodstream infections in intensive care unit patients at a private tertiary care hospital in Mumbai, India. Indian J Med Microbiol. 2019; 37(4): 521 – 6. doi: 10.4103/ijmm.IJMM_20_3.
9. Pathak A, Tejan N, Dubey A, Chauhan R, et al. Outbreak of colistin resistant, carbapenemase (*bla*$_{NDM}$, *bla*$_{OXA-232}$) producing *Klebsiella pneumoniae* causing blood stream infection among neonates at a tertiary care hospital in India. Front Cell Infect Microbiol. 2023; 13: 1051020. doi: 10.3389/fcimb.2023.1051020.
10. Robinson ML, Johnson J, Naik S, Patil S, et al. Maternal Colonization Versus Nosocomial Transmission as the Source of Drug-Resistant Bloodstream Infection in an Indian Neonatal Intensive Care Unit: A Prospective Cohort Study. Clin Infect Dis. 2023; 77(Suppl 1): S38 - S45. doi: 10.1093/cid/ciad282.
11. Srivastava AK, Thakur AK, Singh KV, Parveen R, et al. Epidemiology of non-central line-associated primary bloodstream infections in a

network of Indian hospitals: A prospective surveillance study over 7 years (2017-2024). Int J Infect Dis. 2025; 161: 108126. doi: 10.1016/j.ijid.2025.108126.

12. Kaur M, Sophia, Kaur R, Guleria C, Vig S, Angurana SK, Biswal M, Jayshree M. A quality improvement initiative to reduce central line associated blood stream infection in PICU of a tertiary care hospital in North India. Indian J Med Microbiol. 2025; 57: 100922. doi: 10.1016/j.ijmmb.2025.100922.

Table 1: Demographic and device-related characteristics according to cannula-tip culture

Characteristic	Culture result		Test statistic	p-value
	Positive (n=38)	Negative (n=112)		
Age, years*	5.8 ± 4.2	6.4 ± 4.5	t=0.72	0.472
Male **	23 (60.5)	62 (55.4)	χ^2=0.31	0.579
Undernutrition**	17 (44.7)	28 (25.0)	χ^2=5.26	0.022
Cannula dwell time, hours*	76.6 ± 25.4	51.8 ± 20.7	t=6.04	<0.001
Dwell time >72 hours**	24 (63.2)	25 (22.3)	χ^2=21.49	<0.001
> one insertion attempt**	19 (50.0)	28 (25.0)	χ^2=8.31	0.004
Cannula inserted during emergency**	16 (42.1)	25 (22.3)	χ^2=5.65	0.017
*mean ± SD; **n (%)				

Table 2: Microorganisms isolated from culture-positive cannula tips and antimicrobial resistance pattern

Isolate	Number (%)	Frequently observed resistance
Staphylococcus aureus	11 (28.9)	Penicillin: 9/11 (81.8%); cefoxitin: 4/11 (36.4%)
Coagulase-negative staphylococci	10 (26.3)	Erythromycin: 5/10 (50.0%); clindamycin: 3/10 (30.0%)
Klebsiella pneumoniae	6 (15.8)	Ceftriaxone: 4/6 (66.7%); ciprofloxacin: 3/6 (50.0%)
Pseudomonas aeruginosa	4 (10.5)	Ceftazidime: 2/4 (50.0%); ciprofloxacin: 1/4 (25.0%)
Escherichia coli	3 (7.9)	Ceftriaxone: 2/3 (66.7%); cotrimoxazole: 2/3 (66.7%)
Enterococcus species	2 (5.3)	High-level gentamicin: 1/2 (50.0%)
Acinetobacter species	2 (5.3)	Carbapenems: 1/2 (50.0%)
Total	38 (100.0)	—

Table 3: Association of local cannula complications with microbial colonisation

Local complication	Culture result		Odds ratio (95% CI)	p-value
	Positive	Negative		
Phlebitis	20 (52.6)	18 (16.1)	5.80 (2.57–13.09)	<0.001
Erythema	18 (47.4)	16 (14.3)	5.40 (2.36–12.37)	<0.001
Pain or tenderness	17 (44.7)	20 (17.9)	3.72 (1.68–8.25)	<0.001
Swelling or infiltration	12 (31.6)	18 (16.1)	2.41 (1.03–5.66)	0.039
Cannula blockage	14 (36.8)	21 (18.8)	2.53 (1.12–5.72)	0.023
Local discharge	6 (15.8)	2 (1.8)	10.31 (1.99–53.36)	0.002
Any local complication	27 (71.1)	37 (33.0)	4.98 (2.25–11.00)	<0.001